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Energy to Serve Your World℠

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U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D. C. 20555-0001

Joseph M. Farley Nuclear Plant – Unit 1
Cycle 22 Core Operating Limits Report

Ladies and Gentlemen:

In accordance with Technical Specification 5.6.5.d, Southern Nuclear Operating Company submits the enclosed Core Operating Limits Report (COLR) for Farley Nuclear Plant Unit 1 Cycle 22, Rev. 0.

This letter contains no NRC commitments. If there are any questions, please advise.

Sincerely,

B. J. George
Manager, Nuclear Licensing

BJG/CHM/phr

Enclosure: FNP Core Operating Limits Report Unit 1– Cycle 22, Rev. 0

cc: Southern Nuclear Operating Company
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Joseph M. Farley Nuclear Plant – Unit 1
Cycle 22 Core Operating Limits Report

Enclosure

FNP Core Operating Limits Report Unit 1– Cycle 22, Rev. 0

SOUTHERN COMPANY

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Joseph M. Farley Nuclear Plant

Core Operating Limits Report

Unit 1 - Cycle 22

Revision 0

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for FNP UNIT 1 CYCLE 22 has been prepared in accordance with the requirements of Technical Specification 5.6.5.

The Technical Requirement affected by this report is listed below:

13.1.1 SHUTDOWN MARGIN - MODES 1 and 2 (with $k_{eff} \geq 1$)

The Technical Specifications affected by this report are listed below:

2.1.1 Reactor Core Safety Limits for THERMAL POWER

3.1.1 SHUTDOWN MARGIN - MODES 2 (with $k_{eff} < 1$), 3, 4 and 5

3.1.3 Moderator Temperature Coefficient

3.1.5 Shutdown Bank Insertion Limits

3.1.6 Control Bank Insertion Limits

3.2.1 Heat Flux Hot Channel Factor - $F_Q(Z)$

3.2.2 Nuclear Enthalpy Rise Hot Channnel Factor - $F_{\Delta H}^N$

3.2.3 Axial Flux Difference

3.3.1 Reactor Trip System Instrumentation Overtemperature ΔT ($OT\Delta T$) and Overpower ΔT ($OP\Delta T$) Setpoint Parameter Values for Table 3.3.1-1

3.4.1 RCS DNB Parameters for Pressurizer Pressure, RCS Average Temperature, and RCS Total Flow Rate

3.9.1 Boron Concentration

2.0 OPERATING LIMITS

The cycle-specific parameter limits for the specifications listed in Section 1.0 are presented in the following subsections. These limits have been developed using NRC-approved methodologies, including those specified in Technical Specification 5.6.5.

2.1 SHUTDOWN MARGIN - MODES 1 and 2 (with $k_{eff} \geq 1.0$) (Technical Requirement 13.1.1)

2.1.1 The SHUTDOWN MARGIN shall be greater than or equal to 1.77 percent $\Delta k/k$.

2.2 SHUTDOWN MARGIN - MODES 2 (with $k_{eff} < 1.0$), 3, 4 and 5 (Specification 3.1.1)

2.2.1 Modes 2 ($k_{eff} < 1.0$), 3 and 4 - The SHUTDOWN MARGIN shall be greater than or equal to 1.77 percent $\Delta k/k$.

2.2.2 Mode 5 - The SHUTDOWN MARGIN shall be greater than or equal to 1.0 percent $\Delta k/k$.

2.3 Moderator Temperature Coefficient (Specification 3.1.3)

2.3.1 The Moderator Temperature Coefficient (MTC) limits are:

The BOL/ARO-MTC shall be less than or equal to $+0.7 \times 10^{-4}$ $\Delta k/k/°F$ for power levels up to 70 percent RTP with a linear ramp to 0 $\Delta k/k/°F$ at 100 percent RTP.

The EOL/ARO/RTP-MTC shall be less negative than -4.3×10^{-4} $\Delta k/k/°F$.

2.3.2 The MTC Surveillance limits are:

The 300 ppm/ARO/RTP-MTC should be less negative than or equal to -3.65×10^{-4} $\Delta k/k/°F$.

The 100 ppm/ARO/RTP-MTC should be less negative than -4.0×10^{-4} $\Delta k/k/°F$.

where: BOL stands for Beginning of Cycle Life
ARO stands for All Rods Out
EOL stands for End of Cycle Life
RTP stands for RATED THERMAL POWER

2.4 Shutdown Bank Insertion Limits (Specification 3.1.5)

2.4.1 The shutdown banks shall be withdrawn to a position greater than or equal to 225 steps.

2.5 Control Bank Insertion Limits (Specification 3.1.6)

2.5.1 The control rod banks shall be limited in physical insertion as shown in Figure 1.

2.6 Heat Flux Hot Channel Factor - $F_Q(Z)$ (Specification 3.2.1)

2.6.1 $F_Q(Z) \leq \frac{F_Q^{RTP}}{P} * K(Z)$ for P > 0.5

$F_Q(Z) \leq \frac{F_Q^{RTP}}{0.5} * K(Z)$ for P ≤ 0.5

where: $P = \frac{THERMAL\ POWER}{RATED\ THERMAL\ POWER}$

2.6.2 $F_Q^{RTP} = 2.50$

2.6.3 K(Z) is provided in Figure 2.

2.6.4 $F_Q(Z) \leq \frac{F_Q^{RTP} * K(Z)}{P * W(Z)}$ for P > 0.5

$F_Q(Z) \leq \frac{F_Q^{RTP} * K(Z)}{0.5 * W(Z)}$ for P ≤ 0.5

2.6.5 W(Z) values are provided in Table 4.

2.6.6 The $F_Q(Z)$ penalty factors are provided in Table 1.

2.7 Nuclear Enthalpy Rise Hot Channel Factor - $F_{\Delta H}^{N}$ (Specification 3.2.2)

2.7.1 $F_{\Delta H}^{N} \leq F_{\Delta H}^{RTP} * (1 + PF_{\Delta H} * (1 - P))$

where: $P = \frac{THERMAL\ POWER}{RATED\ THERMAL\ POWER}$

2.7.2 $F_{\Delta H}^{RTP} = 1.70$

2.7.3 $PF_{\Delta H} = 0.3$

2.8 Axial Flux Difference (Specification 3.2.3)

2.8.1 The Axial Flux Difference (AFD) acceptable operation limits are provided in Figure 3.

2.9 Boron Concentration (Specification 3.9.1)

2.9.1 The boron concentration shall be greater than or equal to 2000 ppm.[1]

2.10 Reactor Core Safety Limits for THERMAL POWER (Specification 2.1.1)

2.10.1 In MODES 1 and 2, the combination of THERMAL POWER, Reactor Coolant System (RCS) highest loop average temperature, and pressurizer pressure shall not exceed the safety limits specified in Figure 4.

2.11 Reactor Trip System Instrumentation Overtemperature ΔT (OTΔT) and Overpower ΔT (OPΔT) Setpoint Parameter Values for Table 3.3.1-1 (Specification 3.3.1)

2.11.1 The Reactor Trip System Instrumentation Overtemperature ΔT (OTΔT) and Overpower ΔT (OPΔT) setpoint parameter values for TS Table 3.3.1-1 are listed in COLR Tables 2 and 3.

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[1] This concentration bounds the condition of $k_{eff} \leq 0.95$ (all rods in less the most reactive rod) and subcriticality (all rods out) over the entire cycle. This concentration includes additional boron to address uncertainties and B^{10} depletion.

2.12 RCS DNB Parameters for Pressurizer Pressure, RCS Average Temperature, and RCS Total Flow Rate (Specification 3.4.1)

2.12.1 RCS DNB parameters for pressurizer pressure, RCS average temperature, and RCS total flow rate shall be within the limits specified below:

a. Pressurizer pressure ≥ 2209 psig;
b. RCS average temperature ≤ 580.3 °F; and
c. The minimum RCS total flow rate shall be ≥ 263,400 GPM when using the precision heat balance method and ≥ 264,200 GPM when using the elbow tap method.

Table 1

$F_Q(Z)$ Penalty Factor

Cycle Burnup (MWD/MTU)	$F_Q(Z)$ Penalty Factor
150	1.020
558	1.031
967	1.031
1375	1.020
4439	1.020
4643	1.028
5664	1.028
6481	1.020
15875	1.020
16079	1.023
16487	1.023
16692	1.020

Notes:

1. The Penalty Factor, to be applied to $F_Q(Z)$ in accordance with SR 3.2.1.2, is the maximum factor by which $F_Q(Z)$ is expected to increase over a 39 EFPD interval (surveillance interval of 31 EFPD plus the maximum allowable extension not to exceed 25 % of the surveillance interval per SR 3.0.2) starting from the burnup at which the $F_Q(Z)$ was determined.
2. Linear interpolation is adequate for intermediate cycle burnups.
3. For all cycle burnups outside the range of the table, a penalty factor of 1.020 shall be used.

Table 2

Reactor Trip System Instrumentation - Overtemperature ΔT (OTΔT)
Setpoint Parameter Values

$T' \leq 577.2$ °F	$P' = 2235$ psig	
$K_1 = 1.17$	$K_2 = 0.017$ / °F	$K_3 = 0.000825$ / psi
$\tau_1 \geq 30$ sec	$\tau_2 \leq 4$ sec	
$\tau_4 = 0$ sec	$\tau_5 \leq 6$ sec	$\tau_6 \leq 6$ sec

$f_1(\Delta I) =$	$-2.48 \{23 + (q_t - q_b)\}$	when $(q_t - q_b) \leq -23$ % RTP
	0 % of RTP	when -23 % RTP $< (q_t - q_b) \leq 15$ % RTP
	$2.05 \{(q_t - q_b) - 15\}$	when $(q_t - q_b) > 15$ % RTP

Table 3

Reactor Trip System Instrumentation - Overpower ΔT (OPΔT)
Setpoint Parameter Values

$T'' \leq 577.2$ °F

$K_4 = 1.10$	$K_5 = 0.02$ / °F for increasing T_{avg}	$K_6 = 0.00109$ / °F when $T > T''$
	$K_5 = 0$ / °F for decreasing T_{avg}	$K_6 = 0$ / °F when $T \leq T''$

$\tau_3 \geq 10$ sec
$\tau_4 = 0$ sec
$\tau_5 \leq 6$ sec
$\tau_6 \leq 6$ sec

$f_2(\Delta I) = 0$ % RTP for all ΔI

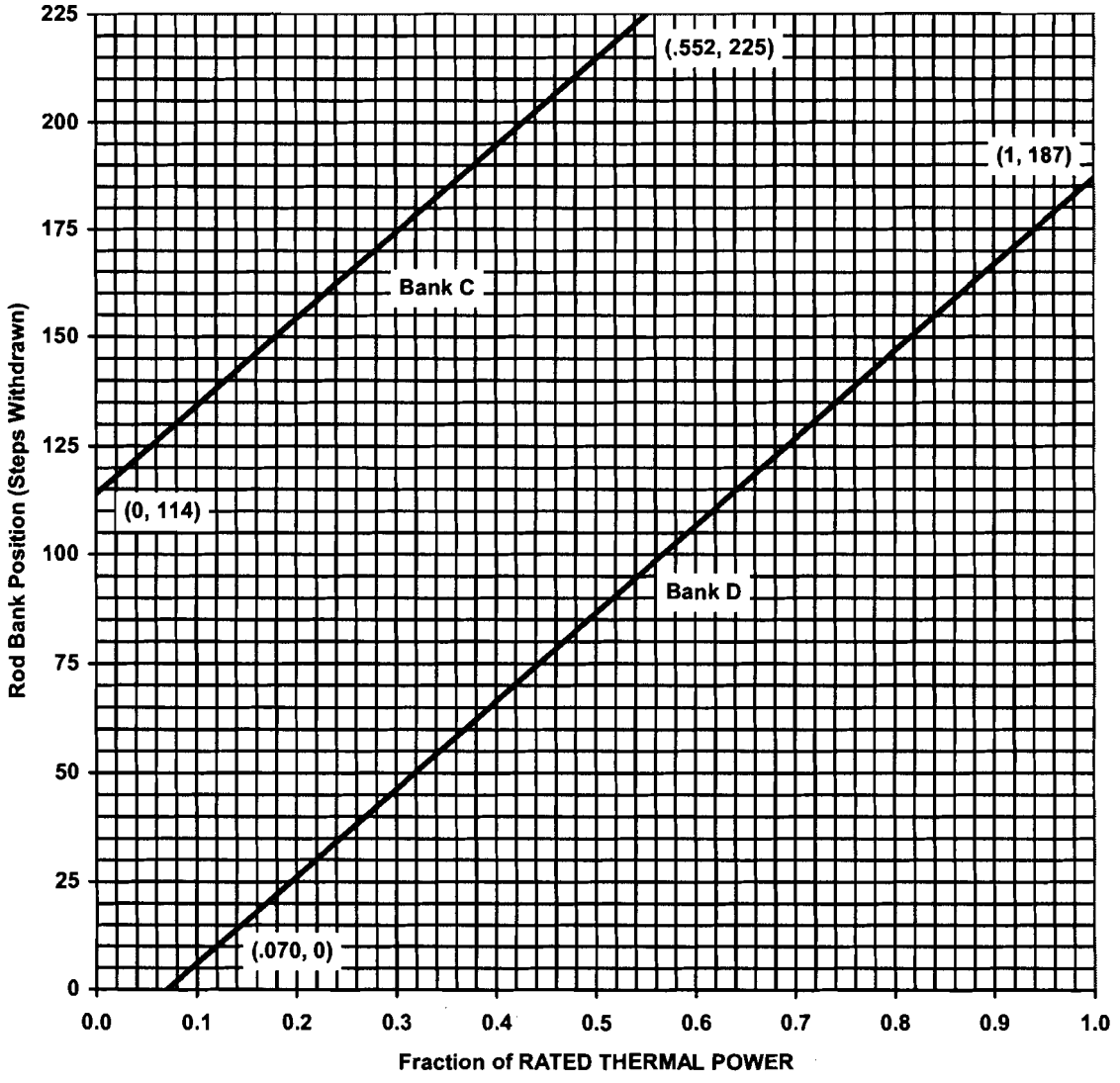
Table 4
RAOC W(Z)

	Axial Point	Elevation (feet)	150 MWD/MTU	3000 MWD/MTU	10000 MWD/MTU	18000 MWD/MTU
*	1	12.00	1.0000	1.0000	1.0000	1.0000
*	2	11.80	1.0000	1.0000	1.0000	1.0000
*	3	11.60	1.0000	1.0000	1.0000	1.0000
*	4	11.40	1.0000	1.0000	1.0000	1.0000
*	5	11.20	1.0000	1.0000	1.0000	1.0000
	6	11.00	1.1356	1.2242	1.2690	1.2906
	7	10.80	1.1338	1.2206	1.2599	1.2754
	8	10.60	1.1323	1.2143	1.2480	1.2555
	9	10.40	1.1305	1.2070	1.2407	1.2342
	10	10.20	1.1454	1.2007	1.2318	1.2182
	11	10.00	1.1507	1.1927	1.2276	1.2113
	12	9.80	1.1506	1.1862	1.2235	1.2128
	13	9.60	1.1493	1.1806	1.2177	1.2193
	14	9.40	1.1470	1.1737	1.2113	1.2250
	15	9.20	1.1423	1.1653	1.2038	1.2283
	16	9.00	1.1367	1.1542	1.1945	1.2381
	17	8.80	1.1381	1.1537	1.1928	1.2435
	18	8.60	1.1467	1.1589	1.1981	1.2649
	19	8.40	1.1567	1.1681	1.2132	1.2875
	20	8.20	1.1642	1.1746	1.2242	1.3090
	21	8.00	1.1696	1.1789	1.2326	1.3268
	22	7.80	1.1746	1.1814	1.2385	1.3406
	23	7.60	1.1779	1.1818	1.2419	1.3507
	24	7.40	1.1793	1.1806	1.2428	1.3569
	25	7.20	1.1790	1.1787	1.2413	1.3596
	26	7.00	1.1770	1.1754	1.2391	1.3587
	27	6.80	1.1736	1.1707	1.2353	1.3546
	28	6.60	1.1690	1.1647	1.2293	1.3475
	29	6.40	1.1631	1.1576	1.2217	1.3376
	30	6.20	1.1562	1.1495	1.2124	1.3250
	31	6.00	1.1489	1.1411	1.2018	1.3097
	32	5.80	1.1417	1.1297	1.1893	1.2929
	33	5.60	1.1432	1.1254	1.1772	1.2719
	34	5.40	1.1567	1.1313	1.1706	1.2514
	35	5.20	1.1681	1.1391	1.1708	1.2465
	36	5.00	1.1786	1.1463	1.1705	1.2436
	37	4.80	1.1886	1.1529	1.1685	1.2381
	38	4.60	1.1975	1.1586	1.1656	1.2308
	39	4.40	1.2055	1.1635	1.1614	1.2213
	40	4.20	1.2123	1.1675	1.1565	1.2097
	41	4.00	1.2180	1.1706	1.1513	1.1967
	42	3.80	1.2224	1.1723	1.1445	1.1829
	43	3.60	1.2255	1.1742	1.1382	1.1680
	44	3.40	1.2277	1.1780	1.1346	1.1536
	45	3.20	1.2285	1.1819	1.1313	1.1425
	46	3.00	1.2367	1.1912	1.1260	1.1426
	47	2.80	1.2493	1.2094	1.1268	1.1552
	48	2.60	1.2742	1.2339	1.1367	1.1725
	49	2.40	1.2987	1.2580	1.1462	1.1884
	50	2.20	1.3230	1.2818	1.1558	1.2041
	51	2.00	1.3468	1.3053	1.1654	1.2196
	52	1.80	1.3699	1.3281	1.1749	1.2350
	53	1.60	1.3921	1.3500	1.1844	1.2503
	54	1.40	1.4131	1.3706	1.1937	1.2654
	55	1.20	1.4327	1.3897	1.2029	1.2803
	56	1.00	1.4505	1.4069	1.2114	1.2946
*	57	0.80	1.0000	1.0000	1.0000	1.0000
*	58	0.60	1.0000	1.0000	1.0000	1.0000
*	59	0.40	1.0000	1.0000	1.0000	1.0000
*	60	0.20	1.0000	1.0000	1.0000	1.0000
*	61	0.00	1.0000	1.0000	1.0000	1.0000

* **Top and bottom 5 axial points excluded per Technical Specification B 3.2.1.**

Figure 1
Rod Bank Insertion Limits versus Rated Thermal Power

Fully Withdrawn – 225 to 231 steps, inclusive



Fully Withdrawn shall be the condition where control rods are at a position within the interval ≥ 225 and ≤ 231 steps withdrawn.

Note: The Rod Bank Insertion Limits are based on the control bank withdrawal sequence A, B, C, D and a control bank tip-to-tip distance of 128 steps.

Figure 2
K(Z) – Normalized $F_Q(Z)$ as a Function of Core Height

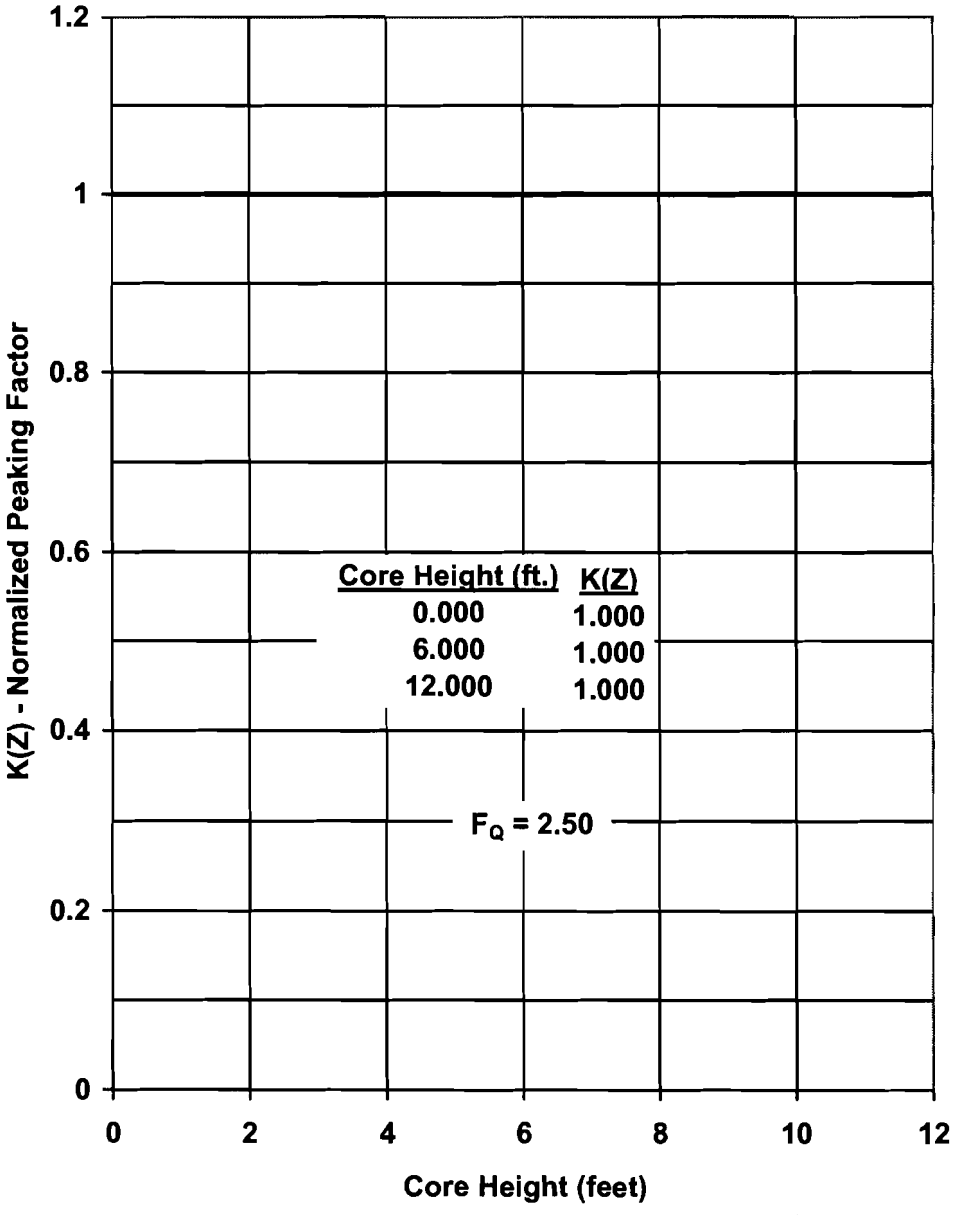


Figure 3
Axial Flux Difference Limits as a Function of
Rated Thermal Power for RAOC

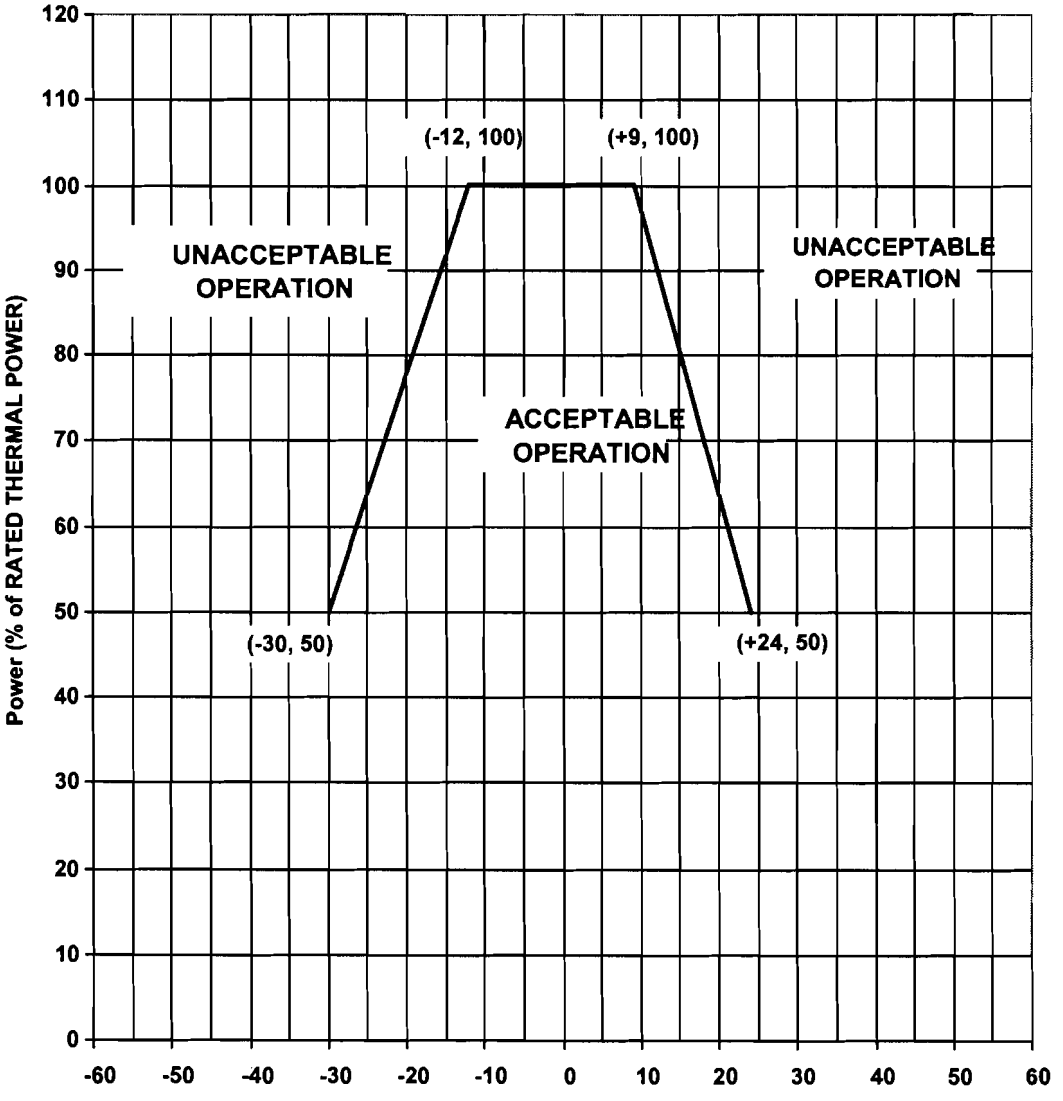


Figure 4
Reactor Core Safety Limits